

Bioprocessing and Bioconversion of Gases and Vapors

Gas/vapor-phase bioreactors and biofilters are useful in a wide variety of applications to treat off-gases. For example, they can be used in environmental remediation systems such as soil vapor extraction and industrial process off-gas streams containing hydrocarbon and halocarbon vapors, odor control, and conversion of “greenhouse” and combustion gases (SO_x and NO_x). Contaminants are converted to innocuous by-products, such as CO_2 , biomass, water, and salts.

In thin-film gas-phase bioreactors and biofilters, microorganisms are cultured as a biofilm on support media in a gas-phase atmosphere. Depending on the application, the support can be inert materials, such as polypropylene rings used in biotrickling filters. Compost is used in biofilters. Targeted gas and vapor mixtures are passed into the bioreactor where they are degraded by microbes in the biofilm. It is believed that gas/vapor mass transfer limitations inherent in liquid-phase bioreactors are significantly decreased in the gas/vapor-phase bioreactors, thereby increasing conversion rates.

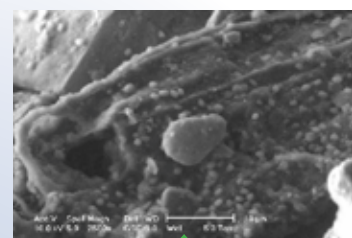
Progress

One INL biofilter, the Bio-cube, received an R&D 100 Award in 1993. It has since been developed and commercialized. A full-scale biofilter has been installed and is operating as a control technology for hydrogen sulfide and volatile organic compound emissions produced during the mixing of asphalt. This biofilter removes hydrogen sulfide components of the off-gas stream. Optimization of the system for complete treatment of all components of the off-gas stream continues. This

work has demonstrated that biofilters scale linearly from laboratory units.

An anaerobic biofiltration system for removing SO_x and NO_x from combustion gases has also been studied. Laboratory research showed high combustion gas removal efficiencies in biofilters operated at empty bed residence times of less than 13 seconds.

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Micrograph of bacteria on biofilter media.

Asphalt vapors biofilter.



Experimental-scale NO_x biofilters.

The Energy of Innovation

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Selected Publications/Presentations/Patents

B. D. Lee, W. A. Apel, and W. A. Smith, "Oxygen Effects on Thermophilic Microbial Populations in Biofilters Treating Nitric Oxide Containing Off-gas Streams, *Environmental Progress*, Vol. 20, No. 3, 2001, pp. 1–10.

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L. L. Cook, T. B. Hubler, W. A. Apel, K. S. Noah, and P. A. Gostomski, "Biofiltration of Asphalt Emissions: Full-scale Operation Treating Odorous Gases from Asphalt Product Storage and Loading Facilities," paper 816, *Proceedings of the 93rd Annual Meeting of the Air and Waste Management Association*, Salt Lake City, 2000.

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G. Andrews and W. A. Apel, "Bioreactors, Gas Treatment," *Encyclopedia of Bioprocess Technology: Fermentation, Biocatalysis, and Bioseparation*, eds. M. C. Flickinger and S. W. Drew, New York: John Wiley & Sons, Inc., 1999, pp. 381–394.

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B. D. Lee, W. A. Apel, and W. Smith, "Effect of Oxygen on Thermophilic Dentrifying Populations in Biofilters Treating Nitric Oxide Containing Off-Gas Streams, *Proceedings of the 91st Annual Meeting and Exhibition of the Air and Waste Management Association*, St. Louis, June 1999, Paper 99, p. 322.

B. D. Lee and W. A. Apel, "Evaluation of NO_x Removal Using Compost Based Biofilters Operated under Denitrifying Conditions," *Proceedings of the 1998 Conference on Biofiltration*, University of Southern California, Los Angeles, 1998, pp. 51–59.

B. D. Lee, W. A. Apel, M. R. Walton, A. R. Miller, and L. Gabrylczyk, "Comparison of Anaerobic Biofilters and Anaerobic Biotrickling Filters for Carbon Tetrachloride Removal from Synthetic Off-Gas Streams," *Proceedings of the 91st Annual Meeting and Exhibition of the Air and Waste Management Association*, San Diego, June 1998, Paper 98-MP20A.07.

B. D. Lee and W. A. Apel, "Biofilter Development for Removal of Environmentally Significant Contaminants from Off-Gas Streams," *Proceedings of the Chemical Engineering Exposition and Conference, Volume IV, Advances in Reactions and Separations*. Houston, June 3–4, 1998.

For more information

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